

THE DEVELOPMENT OF A CHEMIGATION SYSTEM FOR THE APPLICATION OF DAIRY WASTEWATER

by

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Summary:

The Idaho Law governing chemigation of dairy waste will be discussed to demonstrate what may be required of the dairy facilities in Idaho. Two chemigation systems that are currently in place were evaluated to determine if they met the minimum requirements of the Idaho Pesticide and Chemigation Law for applying dairy wastewater and the method of application for these systems will be discussed. A pilot project is being developed with the cooperation of an Idaho dairyman and commercial dealers to develop a system that will meet the chemigation requirements and apply dairy wastewater in an efficient manner through a center pivot system.

Keywords:

Chemigation, center pivot, effluent, lagoon, land application

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INTRODUCTION

The dairy industry in Idaho has experienced significant changes in the last four years. In 1995, a Memorandum of Understanding (MOU) was signed between the Environmental Protection Agency (EPA), the Idaho Division of Environmental Quality (IDEQ), the Idaho State Department of Agriculture (ISDA), and the Idaho Dairymen's Association (IDA). The MOU transferred waste inspections and rule making authority for dairy facilities in the State of Idaho from IDEQ to ISDA. Through the MOU, ISDA developed a series of rules regarding waste produced on dairy facilities. The first phase of the MOU dealt with waste containment. The next phase deals with the land application of solid and liquid waste that is produced on dairy facilities through the development of Nutrient Management Plans (NMPs). It is quickly becoming apparent that the application of this waste, primarily the liquid waste (i.e. effluent), must be applied in a uniform manner and not be a nuisance to the public. The majority of the effluent has been applied through large sprinkler heads mounted on top of pivots or through wheel/handline. This method typically does not provide a uniform application of effluent nutrients and raises concerns from the public due to odor, aesthetics, and groundwater/surface water pollution.

To address these concerns and potential harm to water, ISDA is beginning to assist the dairymen in determining the best method of applying effluent. In order to provide a more uniform application of nutrients and reduce odor/aesthetic concerns, the effluent needs to be applied at diluted rates through a uniform irrigation. This will require that effluent be mixed with irrigation water and land applied during normal irrigation sets or "chemigating" with dairy effluent. Under the Idaho Pesticide and Chemigation Law (Chapter 34, Title 22, Idaho Code), a chemical is defined as "any fertilizer or pesticide". Fertilizer is defined as "any formulation or product used as a plant nutrient which is intended to promote plant growth and contains one or more plant nutrients". Recently, this definition of fertilizer was interpreted by a State of Idaho Attorney General to include any water from a CAFO/AFO that has come into contact with manure and is collected in a containment structure to later be land applied. The State of Idaho Legislature then attempted to pass a law that included dairy wastewater in the Idaho Pesticide and Chemigation Law. Under this law, dairy effluent when mixed with irrigation water or applied through an irrigation system that is connected to the main water supply, must meet the requirements of the Idaho Pesticide and Chemigation Law and IDAPA 02.03.04 – Rules Governing Chemigation. This law was defeated in the Legislative hearings, but will continue to be an issue until the situation is resolved.

Since this topic will remain a sensitive issue within the Idaho Legislature and with the citizens of Idaho, ISDA is currently developing a chemigation system for the application of dairy effluent. In addition, ISDA will continue to ensure that the dairymen who are applying effluent through irrigation meet the requirements of the Idaho Pesticide and Chemigation Law and IDAPA 02.03.04. The minimum requirements for chemigation under these rules are that the chemical injection line has a quick closing check valve with a solenoid or hydraulically operated valve, a pressure switch, a metering pump, and system interlock. There are additional requirements depending on the type of irrigation system that is being used. In most cases, effluent is being applied through a sprinkler irrigation system that may or may not be connected to a domestic water supply. The sprinkler chemigation systems are required to have an irrigation line check valve with an automatic low-pressure drain, an inspection port, and a vacuum relief valve. If the system is connected to a domestic water supply, the irrigation system line must have a reduced pressure zone backflow preventer (RPZ).

line to the pivot, the system does have a check valve with a combination of an air vent and a vacuum relief valve. However, in order for this system to meet the full requirements of the Idaho Pesticide and Chemigation Law and IDAPA 02.03.04, an inspection port and a low-pressure drain with at least 6 m (20 ft) of hose must be installed on the check valve. A schematic of the existing chemigation system and what will need to be added to correct the system is available in Figure 3 of Appendix A.

CP-2 is a half circle Zimmatic center pivot system that is 274 m (898 ft) long and operates at 30 lps (475 gpm) and 345 kpa (50 psi). Along this pivot, two Nelson SR Series guns have been installed approximately 85m (280 ft) apart. The innermost gun has a nozzle diameter of 1.78 cm (0.7 in) and operates at 6.3 lps (100 gpm). At an optimal performance of 345 kpa (50 psi), this nozzle can cover a diameter of 75 m (245 ft). The outermost gun has a nozzle diameter of 2.29 cm (0.9 in). This will produce a flowrate of 10.2 lps (162 gpm) with a 84 m (275 ft) coverage diameter at 331 kpa (48 psi). As can be seen in the coverage layout in Figure 2 of Appendix A, this pivot also has a coverage distribution problem that has a “doughnut” effect that is more extreme than CP-1.

CP-2's chemigation system is very comparable to that of CP-1. A butterfly valve that is opened manually is located on the effluent line. Again, no chemigation protection equipment is needed along this line. The irrigation line has a check valve with a vacuum relief valve located on the upstream side of the pipe. This system is also missing two components needed to meet the current chemigation regulations. The check valve needs to contain an inspection port and a low-pressure drain with 6 m (20 ft) of hose. The inspection port should be located directly over the low-pressure drain, as can be seen in Figure 3 of Appendix A.

CP-3 is also a half circle Zimmatic center pivot system. It is 462 m (1515 ft) in length and is designed to operate at 345 kpa (50 psi) and 41.6 lps (660 gpm). This pivot has four Nelson SR Series guns spaced every 85 m (280 ft). The innermost gun is operating at 379 kpa (55 psi) with a 1.40 cm (0.55 in) nozzle. The approximate coverage diameter for this nozzle is 63 m (208 ft) at 3.8 lps (61 gpm). Next, there is a 1.65 cm (0.65 in) nozzle operating at 365 kpa (53 psi). At optimal performance this nozzle should produce 5.1 lps (81 gpm) with a coverage diameter of 69 m (226 ft). The second to last gun will cover a diameter of 74 m (243 ft) at 358 kpa (52 psi). This 1.91 cm (0.75 in) nozzle has a flowrate of 6.6 lps (105 gpm). The last nozzle along CP-3 is 2.16 cm (0.85 in) in diameter operating at 348 kpa (50-51 psi). The approximate coverage diameter and flowrate are 83 m (273 ft) and 9.5 lps (150 gpm), respectively. This system also produces the same field effects as CP-1 and CP-2, but to a greater extent since it is a longer pivot with smaller nozzle diameters at the same spacing as CP-1 and CP-2 as seen in Figure 2 of Appendix A.

The chemigation system for CP-3 consists of a butterfly valve on the effluent line with no chemigation protection devices. Once again, this is not a necessity since the effluent is not being mixed and will drain back into the lagoon. The irrigation line contains a gooseneck with the vacuum relief valve located on its apex. Downstream from this point is a booster pump connected to a butterfly valve and a chemigation check valve. However, this check valve does not contain an inspection port or a low-pressure drain. Figure 3 in Appendix A provides a visual aid for determining the system layout. All of the chemigation systems are missing two essential components for a chemigation system to meet current Idaho regulations governing chemigation. Dairy facilities in the state are not currently required to meet these regulations, but will have to in the near future. It was recommended that this dairyman replace his existing chemigation check valves on the irrigation lines at each pivot point to meet current state chemigation regulations.

turbine supply pumps were to shut off and the irrigation water supply pumps and the effluent supply pumps were to continue pumping, the water would enter the lagoon through the overflow pipe before any backflow to the irrigation water sources could occur. The irrigation supply inlet pipes are also set 15-20 cm (6-8 in) above the ground level of the east embankment. This adds another degree of safety in case the overflow pipe could not handle all of the water. The mixing pond water would then overtop the east embankment and run downhill until it reached the lagoon. This would be considered a discharge of effluent, but no major environmental harm or surface water contamination would occur. Also, if the lagoon were to fill up due to overflow, this would cause backflow into the earthen settling ponds. If water were to overfill these settling ponds, it could reach one of the canals, but it would take an excessive amount of water to do so. Figure 2 in Appendix B provides a layout of the mixing pond system. No recommendations were made to alter this system.

The two Treasure Valley Dairy systems will be evaluated for application uniformity using ASAE Standard 436.1. During this testing period, each waste system may be evaluated for solids removal efficiency. Samples would be collected at the pipe inlet of each waste system and after the separation systems. These samples would then be tested for total suspended solids (TSS) in order to determine the true removal efficiency of the system. The nutrient content of the water after it has been land applied may also be tested to determine how the applications compare to chemical fertilizer applications.

After evaluating the Treasure Valley application methods, a preliminary design of a chemigation system was developed for a dairy in the Magic Valley area of Idaho. The Magic Valley Dairy is presently upgrading its waste system to manage 1000 Holstein & Jersey milking cows. There will be approximately a 3:1 ratio of Holsteins to Jerseys. A total of 15% of the milking herd's solid waste will enter the effluent waste stream. The effluent will enter a two-cell concrete, gravity separator, which will remove approximately 60% of the solid particles. The effluent will then be pumped to a storage pond with a storage capacity of 5937 m³ (209,675 ft³). A site layout of the new waste system has been provided in Figure 1 of Appendix C.

The intention of ISDA is to develop a chemigation system that will provide a 10-20% mix of effluent with irrigation water. The present irrigation system consists of a $\frac{3}{4}$ turn, 50.6 ha (125 acre) center pivot that irrigates both alfalfa and corn silage. It was designed to operate at 483 kpa (70 psi) with a 41 lps (650 gpm) flowrate. Each drop has 138 kpa (20 psi) regulators and Nelson D3000 red plate sprinklers. The pivot is approximately 454 m (1489 ft) in length. The center pivot system pumps irrigation water from a pond located directly south of the pivot point. This water is supplied to the irrigation pond through a pipe connected to an irrigation ditch. The pond, once lined, could work as a mixing pond for the effluent and irrigation water. However, overflow from the irrigation pond would flow to an injection well, which transports this water to another irrigation ditch off of the producer's property. According to the irrigation company, this injection well can not be removed. Therefore, this pond could not be used as a mixing pond.

Due to this, a system very similar to the Treasure Valley #2 (Agri-Lines Irrigation) system will be constructed in order to mix effluent with irrigation water. In the northwest corner of the lagoon, an 2.4 m (8 ft) long section of corrugated steel pipe with a 1.2 m (4 ft) diameter will be placed on end approximately 0.46 m (1.5 ft) deep into a 1.8-m x 1.8-m x 0.61-m (6-ft x 6-ft x 2-ft) concrete slab to form a pump station. Throughout this section of pipe, there will be a series of 1.27 cm (0.5 in) holes to allow effluent to enter the pump station. Within this pipe, wire mesh may be attached over the holes to provide further separation of the solid particles and prevent clogging of the irrigation system. From this pump station, effluent will be pumped into a mixing pond located directly north of the northeast corner of the lagoon using a 1 $\frac{1}{2}$ HP, 5.1 cm (2 in)

REFERENCES

Personal Communication – Dougal, Mark, Agri-Lines Irrigation, Parma Idaho

Personal Communication – Forsberg, Jeff, Agri-Lines Irrigation, Parma Idaho

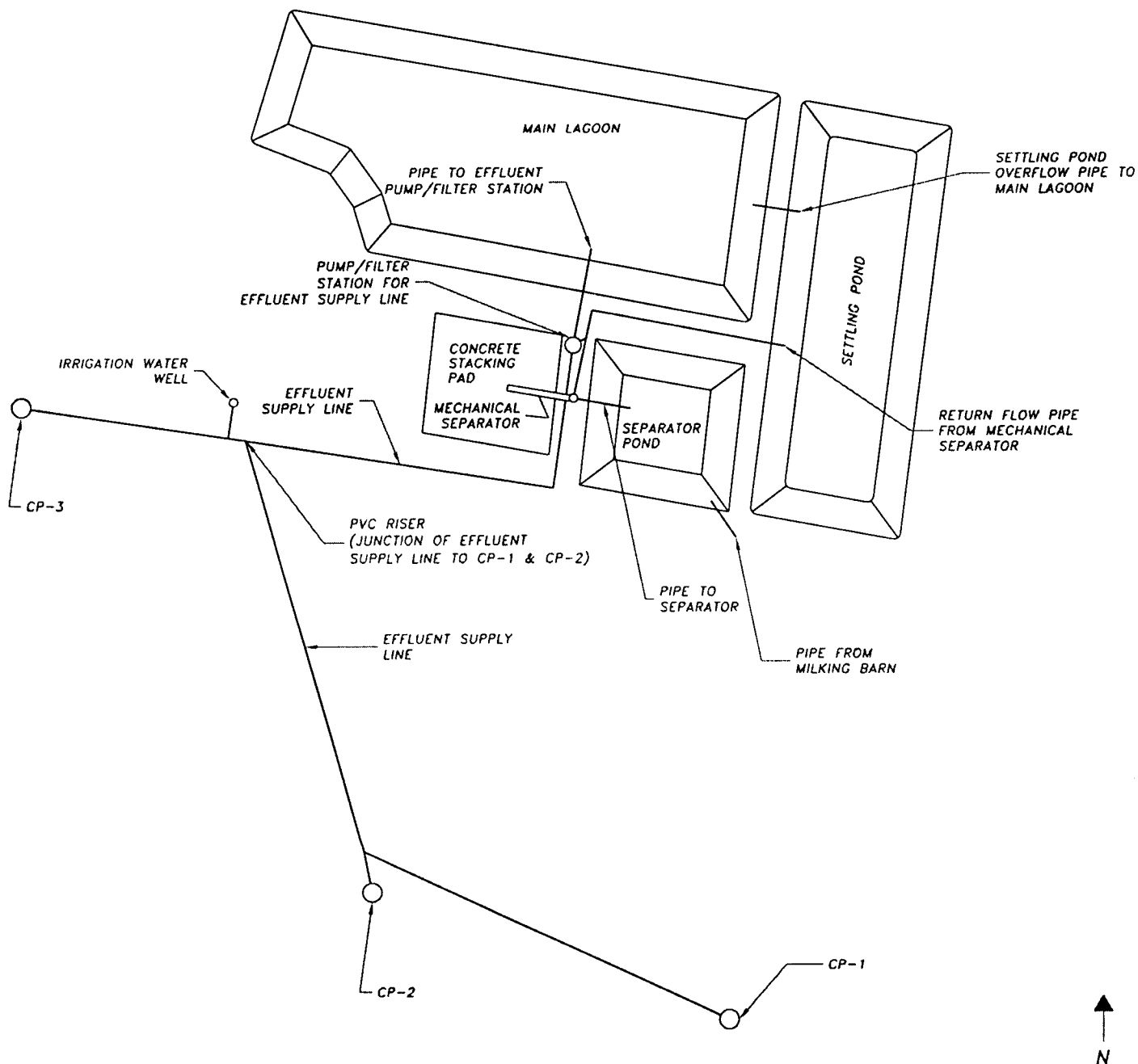
Personal Communication – Looten, Phil, Treasure Valley Dairy #1, Idaho

Personal Communication – Miller, Blaine, Magic Valley Dairy, Idaho

Personal Communication – Welton, Tony, Treasure Valley Dairy #2, Idaho

APPENDICES

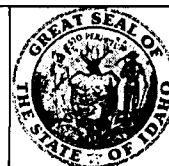
APPENDIX A



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LEGAL DESCRIPTION: NOT PROVIDED

GPS COORDINATES: NOT PROVIDED

DESIGNED BY: NOT PROVIDED

FIGURE 1. TREASURE VALLEY DAIRY #1 WASTE SYSTEM

DRAWN BY: TRAVIS KATOR

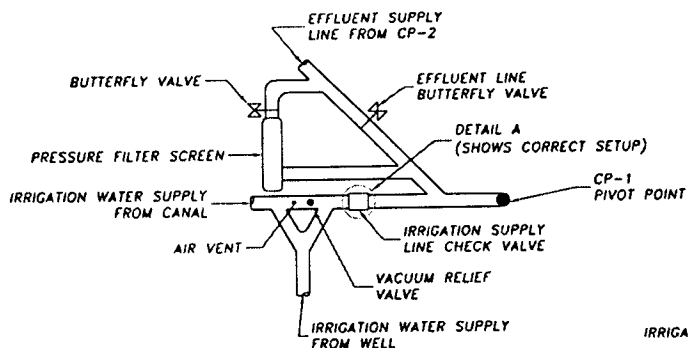
TREASURE VALLEY DAIRY #1

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DATE: 06/25/99 FILE NAME: TV#1 WS.DWG

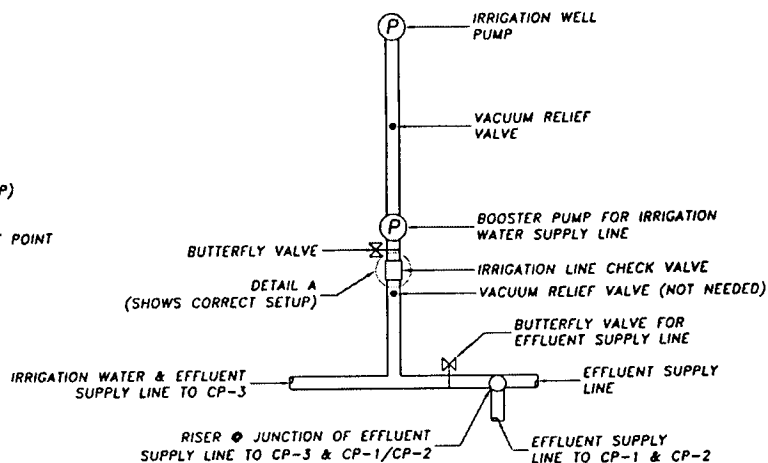
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SHEET: 1 OF 1



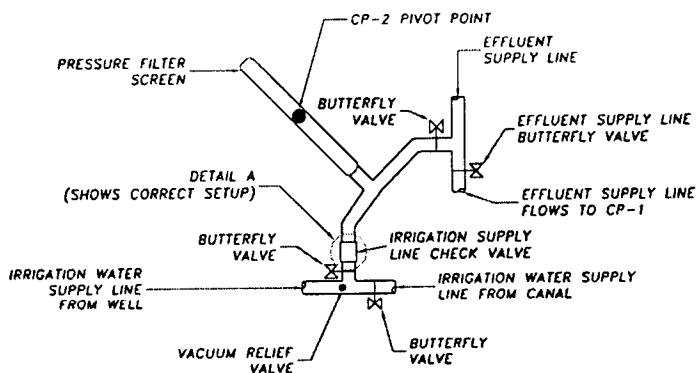
CP-1 CHEMIGATION SYSTEM

(TOP VIEW)



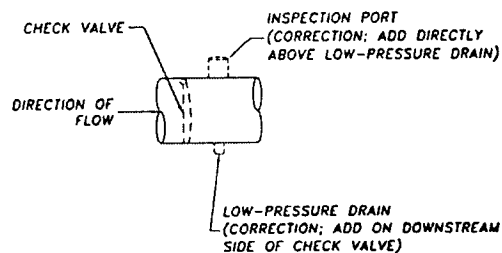
CP-3 CHEMIGATION SYSTEM

(TOP VIEW)



CP-2 CHEMIGATION SYSTEM

(TOP VIEW)



DETAIL A

CHECK VALVE CORRECT SETUP
(SIDE VIEW)



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FIGURE 3. TREASURE VALLEY DAIRY #1 CHEMIGATION SYSTEMS

DRAWN BY: TRAVIS KATOR

TREASURE VALLEY DAIRY #1

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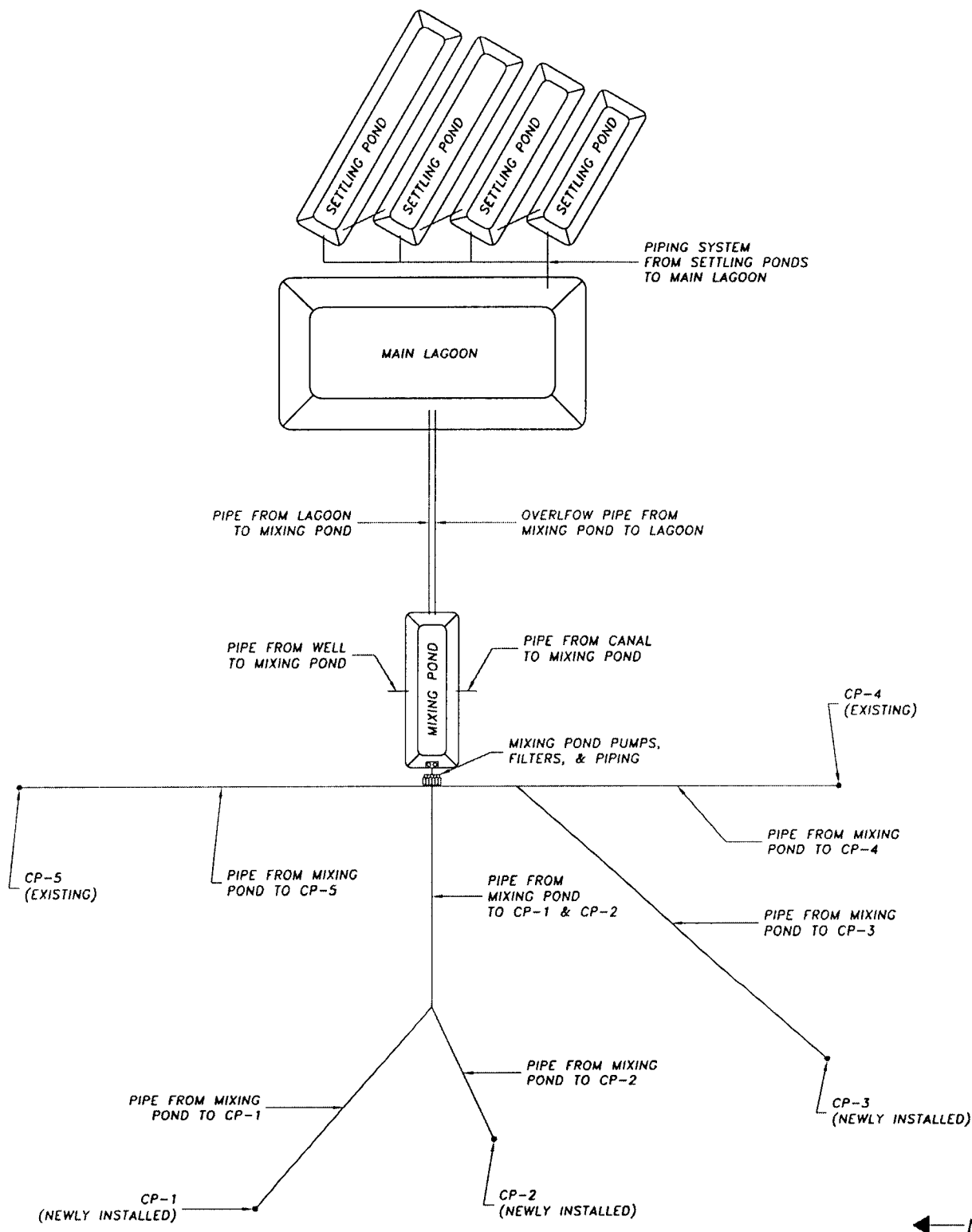
DATE: 06/25/99

FILE NAME: TV#1 CHEMIGATION.DWG

SCALE: NO SCALE

SHEET: 1 OF 1

APPENDIX B



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FIGURE 1. TREASURE VALLEY DAIRY #2 WASTE SYSTEM

DRAWN BY: TRAVIS KATOR

TREASURE VALLEY DAIRY #2

IDAHO

DATE: 06/30/99 FILE NAME: TV#2 WS.DWG

SCALE: NO SCALE

SHEET: 1 OF 1

1999 LINDSAY GEN 4-90

JANUARY 20, 1999

WISHNW-3510

DEALER

AGRI LINES IRRIGATION
115 NORTH SECOND
PARMA, IDAHO 83660

CP-1

TREASURE VALLEY
DAIRY #2

TOTAL TARGET GPM 1400.00
PIVOT PRESSURE 52.00
ENDGUN TARGET GPM 124.29
NUMBER OF OUTLETS 228

FRICTION FACTOR USED 138
TOTAL LENGTH 1614.53
NUMBER OF TOWERS 9
NUMBER OF SPRINKLERS 188

PIPE I.D. LENGTH
7.770 718.60
6.395 882.08
5.389 33.87

NELSON R2000 ROTATORS WITH DA GREEN PLATES FIRST 20 POSITIONS
NELSON D3000 SPRAYS WITH FLAT FINE GROOVE PLATES BALANCE
NELSON BLUE TOP 25 PSI AND 20 HF INTEGRAL SERIES REGULATORS
HOSES AVERAGE 2.5 FT OF 7.5 IN. FI. EXIBLE HOSE WITH EXTERNAL GALVANIZED WEIGHTS
ELEVATION IS 0 FT UP AND 0 FT DOWN

CAUTIONS AND WARNINGS

CAUTIONS AND WARNINGS

1. Inadequate crop clearance and/or structural interference may cause poor water distribution, resulting in decreased uniformity and possible streaking.
2. Over watering at beginning of system due to practical limitations of smallest nozzle sizes available and/or allowable for proper operation.
3. Mixing of two or more different sprinkler types usually results in pattern variances at the point where the sprinklers are different. Sprinkler types, due to differences in water pattern and distance of throw.
4. Endgun matched to booster pump maximum. This statement means that to match the precipitation rate of the main line of the endgun is machine the required flow of the endgun is unattainable due to the flow restriction of the booster pump.

55-1-22-NH

OUTLET LAST DISTANCE GPM GPM PIPE NOZZLE SPRINKLER LABEL AND SPRK REG PLUG PAGE
NO. OUTLET TO PIVOT NEED DEL PSI PSI NO. SIZE NO. DROPP LENGTH

45		326.26	4.79	4.59	47.04	25.75	R3000 23 YEL/RED	19	NMB25LF	27	81
46	14.63	333.59									
47		340.93									
48	14.67	348.26	5.46	5.45	46.04	25.69	R3000 25 RED/WHITE	20	NMB25LF	28	78
49		355.76									
POWER 2	179.00	360.60								29	
50		361.59									
51	17.50	365.76	4.42	4.59	46.59	25.78	D3000 23 YEL/RED	21	NMB25LF	30	72
52	7.50	373.26	2.69	2.57	46.49	26.40	D3000 17 LAV/GRAY	22	NMB25LF		78
53	7.33	380.59	2.72	2.85	46.38	26.39	D3000 18 GRAY	23	NMB25LF		84
54	7.34	387.93	2.77	2.84	46.28	26.36	D3000 18 GRAY	24	NMB25LF		84
55	7.33	395.26	2.85	2.84	46.18	26.33	D3000 18 GRAY	25	NMB25LF		90
56	7.50	402.76	2.84	2.84	46.08	26.31	D3000 18 GRAY	26	NMB25LF		90
57	7.00	409.76	2.89	2.84	45.98	26.25	D3000 18 GRAY	27	NMB25LF		96
58	7.50	417.26	3.01	2.84	45.88	26.24	D3000 19 GRAY/TURQ	28	NMB25LF		96
59	7.33	424.59	3.03	3.20	45.78	26.22	D3000 19 GRAY/TURQ	29	NMB25LF		102
60	7.34	431.93	3.08	3.20	45.69	26.22	D3000 19 GRAY/TURQ	30	NMB25LF		102
61	7.33	439.26	3.17	3.19	45.59	26.18	D3000 19 GRAY/TURQ	31	NMB25LF		102
62	7.50	446.76	3.15	3.19	45.49	26.18	D3000 19 GRAY/TURQ	32	NMB25LF		102
63	7.00	453.76	3.20	3.19	45.39	26.16	D3000 19 GRAY/TURQ	33	NMB25LF		102
64	7.50	461.26	3.33	3.19	45.29	26.10	D3000 19 GRAY/TURQ	34	NMB25LF		102
65	7.33	468.59	3.34	3.19	45.20	26.10	D3000 19 GRAY/TURQ	35	NMB25LF		102
66	7.34	475.93	3.40	3.54	45.10	26.07	D3000 20 TURQUOISE	36	NMB25LF		102
67	7.33	483.26	3.46	3.54	45.01	26.03	D3000 20 TURQUOISE	37	NMB25LF		96
68	7.50	490.76	3.46	3.54	44.91	26.04	D3000 20 TURQUOISE	38	NMB25LF		96
69	7.00	497.76	3.51	3.54	44.82	26.02	D3000 20 TURQUOISE	39	NMB25LF		96
70	7.50	505.26	3.64	3.54	44.72	25.96	D3000 20 TURQUOISE	40	NMB25LF		90
71	7.33	512.59	3.66	3.54	44.63	25.95	D3000 20 TURQUOISE	41	NMB25LF		84
72	7.34	519.93	3.71	3.83	44.54	25.93	D3000 21 TURQ/YEL	42	NMB25LF		84
73	7.33	527.26	3.80	3.83	44.44	25.89	D3000 21 TURQ/YEL	43	NMB25LF		78
74	7.50	534.76	4.56	4.59	44.35	25.74	D3000 23 YEL/RED	44	NMB25LF		72
POWER 3	179.00	539.60									
75		540.59									
76	10.00	544.76	4.63	4.59	44.22	25.74	D3000 23 YEL/RED	45	NMB25LF	31	72
77	7.50	552.26	3.98	3.82	44.13	25.80	D3000 21 TURQ/YEL	46	NMB25LF		78
78	7.33	559.59	3.99	3.82	44.04	25.80	D3000 21 TURQ/YEL	47	NMB25LF		84
79	7.34	566.93	4.05	4.24	43.95	25.79	D3000 22 YELLOW	48	NMB25LF		84
80	7.33	574.26	4.14	4.23	43.86	25.78	D3000 22 YELLOW	49	NMB25LF		90
81	7.50	581.76	4.10	4.23	43.77	25.78	D3000 22 YELLOW	50	NMB25LF		90
82	7.00	588.76	4.15	4.23	43.69	25.78	D3000 22 YELLOW	51	NMB25LF		96
83	7.50	596.26	4.30	4.23	43.60	25.76	D3000 22 YELLOW	52	NMB25LF		96
84	7.33	603.59	4.31	4.23	43.51	25.76	D3000 22 YELLOW	53	NMB25LF		102
85	7.34	610.93	4.36	4.23	43.42	25.75	D3000 22 YELLOW	54	NMB25LF		102
86	7.33	618.26	4.46	4.59	43.34	25.74	D3000 23 YEL/RED	55	NMB25LF		102
87	7.33	625.76	4.41	4.59	43.25	25.75	D3000 23 YEL/RED	56	NMB25LF		102

OUTLET NO.	LAST OUTLET	DISTANCE TO PIVOT	GPM NEED	GPM DEL.	PIPE PSI	NOZZLE PSI	SPRINKLER LABEL AND NOZZLE SIZE	SPRK NO.	REG SIZE	PLUG NO.	DROP LENGTH
130	7.33	932.26	6.73	7.00	37.97	26.26	D3000 26 BLUE	97	NNB25HF		90
131	7.50	939.76	6.63	6.43	36.92	26.28	D3000 27 WHITE/BLUE	98	NNB25HF		90
132	7.00	946.76	6.68	6.43	36.78	26.26	D3000 27 WHITE/BLUE	99	NNB25HF		96
133	7.50	954.26	6.89	6.99	36.64	26.19	D3000 28 BLUE	100	NNB25HF		96
134	7.33	961.59	6.87	6.99	36.50	26.19	D3000 28 BLUE	101	NNB25HF		102
135	7.34	968.93	6.92	6.99	36.36	26.17	D3000 28 BLUE	102	NNB25HF		102
136	7.33	976.26	7.05	6.98	36.22	26.12	D3000 28 BLUE	103	NNB25HF		102
137	7.50	983.76	6.94	6.98	36.08	26.14	D3000 28 BLUE	104	NNB25HF		102
138	7.00	990.76	6.99	6.98	35.95	26.12	D3000 28 BLUE	105	NNB25HF		102
139	7.50	998.26	7.21	6.97	35.82	26.05	D3000 28 BLUE	106	NNB25HF		102
140	7.33	1005.59	7.18	6.97	35.69	26.05	D3000 28 BLUE	107	NNB25HF		102
141	7.34	1012.93	7.24	7.45	35.56	26.03	D3000 29 BLUE/DK BRN	108	NNB25HF		102
142	7.33	1020.26	7.37	7.44	35.43	25.98	D3000 29 BLUE/DK BRN	109	NNB25HF		96
143	7.50	1027.76	7.26	7.45	35.31	26.01	D3000 29 BLUE/DK BRN	110	NNB25HF		96
144	7.00	1034.76	7.31	7.44	35.19	25.99	D3000 29 BLUE/DK BRN	111	NNB25HF		90
145	7.50	1042.26	7.52	7.43	35.07	25.92	D3000 29 BLUE/DK BRN	112	NNB25HF		90
146	7.33	1049.59	7.50	7.43	34.95	25.92	D3000 29 BLUE/DK BRN	113	NNB25HF		84
147	7.34	1056.93	7.55	7.43	34.83	25.91	D3000 29 BLUE/DK BRN	114	NNB25HF		84
148	7.33	1064.26	7.69	7.42	34.72	25.86	D3000 29 BLUE/DK BRN	115	NNB25HF		78
149	7.50	1071.76	9.14	8.97	34.60	25.41	D3000 32 ORANGE	116	NNB25HF		72
OWER 6	179.00	1076.60									
150		1077.59									
151	10.00	1081.76	9.22	9.07	34.45	20.29	D3000 34 DK GREEN	117	NNB20HF		72
152	7.50	1089.26	7.07	8.06	34.34	20.60	D3000 32 ORANGE	118	NNB20HF		70
153	7.33	1096.59	7.04	8.06	34.23	20.60	D3000 32 ORANGE	119	NNB20HF		84
154	7.34	1103.93	7.89	8.08	34.13	20.59	D3000 32 ORANGE	120	NNB20HF		84
155	7.33	1111.26	8.02	8.07	34.03	20.55	D3000 32 ORANGE	121	NNB20HF		90
156	7.50	1118.76	7.90	8.07	33.92	20.58	D3000 32 ORANGE	122	NNB20HF		90
157	7.00	1125.76	7.94	8.07	33.83	20.57	D3000 32 ORANGE	123	NNB20HF		96
158	7.50	1133.26	8.18	8.06	33.73	20.51	D3000 32 ORANGE	124	NNB20HF		96
159	7.33	1140.59	8.14	8.06	33.63	20.52	D3000 32 ORANGE	125	NNB20HF		102
160	7.34	1147.93	8.20	8.06	33.54	20.50	D3000 32 ORANGE	126	NNB20HF		102
161	7.33	1155.26	8.34	8.59	33.45	20.47	D3000 33 ORN/DK GRN	127	NNB20HF		102
162	7.50	1162.76	8.20	8.06	33.36	20.50	D3000 32 ORANGE	128	NNB20HF		102
163	7.00	1169.76	8.26	8.06	33.27	20.48	D3000 32 ORANGE	129	NNB20HF		102
164	7.50	1177.26	8.50	8.58	33.19	20.43	D3000 33 ORN/DK GRN	130	NNB20HF		102
165	7.33	1184.59	8.46	8.58	33.10	20.43	D3000 33 ORN/DK GRN	131	NNB20HF		102
166	7.34	1191.93	8.51	8.58	33.02	20.42	D3000 33 ORN/DK GRN	132	NNB20HF		102
167	7.33	1199.26	8.66	8.57	32.94	20.38	D3000 33 ORN/DK GRN	133	NNB20HF		96
168	7.50	1206.76	8.52	8.58	32.86	20.41	D3000 33 ORN/DK GRN	134	NNB20HF		96
169	7.00	1213.76	8.57	8.57	32.79	20.40	D3000 33 ORN/DK GRN	135	NNB20HF		90
170	7.50	1221.26	8.81	8.56	32.71	20.34	D3000 33 ORN/DK GRN	136	NNB20HF		90
171	7.33	1228.59	8.78	8.56	32.63	20.35	D3000 33 GRN/DK GRN	137	NNB20HF		84
172	7.34	1235.93	8.83	9.09	32.56	20.34	D3000 34 DK GREEN	138	NNB20HF		84
173	7.33	1243.26	8.98	9.08	32.45	20.30	D3000 34 DK GREEN	139	NNB20HF		70

OUTLET NO.	LAST OUTLET	DISTANCE TO PIVOT	GPM NEED	GPM DEL.	PIPE PSI	NOZZLE PSI	SPRINKLER LABEL AND NOZZLE SIZE	SPRK NO.	REG SIZE	PLUG NO.	DROP LENGTH
217	7.50	1531.82	10.75	10.65	30.99	19.93	D3000 37 FUR/BLK	177	NNB20HF		96
218	7.00	1538.82	10.81	10.65	30.98	19.93	D3000 37 FUR/BLK	178	NNB20HF		96
219	7.50	1546.32	11.13	11.25	30.97	19.89	D3000 38 BLACK	179	NNB20HF		90
220	7.33	1553.65	11.04	11.25	30.96	19.90	D3000 38 BLACK	180	NNB20HF		90
221	7.34	1560.99	11.07	11.25	30.95	19.90	D3000 38 BLACK	181	NNB20HF		84
222	7.33	1568.32	11.22	11.25	30.94	19.89	D3000 38 BLACK	182	NNB20HF		78
223	7.50	1575.82	12.70	12.42	30.93	19.72	D3000 40 DK TURQ	183	NNB20HF		72
TOWER 9	157.00	1580.66									
PIPE ID CHANGES FROM 6.395 TO 5.369											
224	9.21	1585.03	12.83	12.42	30.91	19.70	D3000 40 DK TURQ	184	NNB20HF		72
225	7.50	1592.53	11.56	11.24	30.90	19.85	D3000 38 BLACK	185	NNB20HF		72
226	7.33	1599.86	10.89	10.65	30.89	19.92	D3000 37 PUR/BLK	186	NNB20HF		72
227	6.42	1606.28	9.60	9.53	30.88	20.11	D3000 35 DK GRN/PUR	187	NNB20HF		72
228	5.50	1611.78	8.65	8.56	30.87	20.34	D3000 33 GRN/DK GRN	188	NNB20HF		72
DRAIN-SANDTRAP											
			4.00	3.80			F SPRAY 10 TURQ				
OVERHANG	33.87	1614.53	125.32		ENDGUN	(1) NELSON SR-100 .75 TB					

BOOSTER PUMP AT END ADDS 30.00 PSI TO PIPE PRESSURE FOR A PRESSURE OF 60.91 PSI
FRICTION LOSS THROUGH ENDGUN VALVE IS 1.40 PSI - ENDGUN PRESSURE IS 59.47 PSI

TOTAL GPM = 1466.42
GPA = 6.76

MINIMUM RECOMMENDED REGULATOR INLET PRESSURE IS 29.00 PSI
WITH GRADE-ATED ELEVATION OF .00 FT THE INLET PRESSURE IS 36.15 PSI FOR SPRINKLER 116
THIS POSITION IS THE CLOSEST TO THE MINIMUM RECOMMENDED INLET PRESSURE

HYDRAULICS SUMMARY

TOWER NUMBER	ACRES UNDER SPAN	GPM NEED	ACTUAL GPM	GPM PER ACRE	AVERAGE IN. PER HR DELIVERED UNDER SPAN	AVERAGE IN. DELIVERED FOR REVOLUTION TIME	60 HR
1	2.38	16.09	19.22	8.08	0.018	0.84	1.07
2	7.00	47.35	46.37	6.63	0.015	0.53	0.88

DEALER
AGRI LINES IRRIGATION
115 NORTH SECOND
PARMA, IDAHO 83660

CP-2
TREASURE VALLEY
DAIRY #2

TOTAL TARGET GPM 520.00
PIVOT PRESSURE 52.00
ENDGUN TARGET GPM 77.15
NUMBER OF OUTLETS 177

FRICTION FACTOR USED 138
TOTAL LENGTH 1278.47
NUMBER OF TOWERS 7
NUMBER OF SPRINKLERS 141

PIPE I.D. LENGTH
6.395 718.60
5.369 559.87

NELSON R3000 ROTATORS WITH D4 GREEN PLATES FIRST 18 POSITONS
NELSON D3000 SPRAYS WITH FLAT FINE GROOVE PLATES BALANCE
NELSON BLUE TOP 25 LF INTEGRAL SERIES REGULATORS
DROPS AVERAGE 7.5 FT OF .75 I.D. FLEXIBLE HOSE WITH EXTERNAL GALVANIZED WEIGHTS
ELEVATION IS 0 FT UP AND 0 FT DOWN

CAUTIONS AND WARNINGS

1. Inadequate crop clearance and/or structural interference may cause poor water distribution, resulting in decreased uniformity and possible streaking.
2. Over watering at beginning of system due to practical limitations on smallest nozzle sizes available and/or allowable for proper operation.
3. Mixing of two or more different sprinkler types usually results in pattern variances at the point where the sprinklers mix, due to differences in water pattern and distance of throw.

OUTLET NO.	LAST OUTLET	DISTANCE TO PIVOT	GPM NEED	GPM DEL.	PIPE PSI	NOZZLE PSI	SPRINKLER LABEL AND NOZZLE SIZE	SPRK NO.	REG SIZE	PLUG NO.	DROP LENGTH
45		326.26	-	-	-	-	-	-	-	29	
46	14.83	333.59	2.58	2.57	50.02	26.51	R3000 17 LAV/GRAY	17	NMB25LF		84
47		340.93	-	-	-	-	-	-	-	30	
48	14.67	348.26	2.94	2.84	49.94	26.34	R3000 18 GRAY	18	NMB25LF		78
49		355.76	-	-	-	-	-	-	-	31	
TOWER 2											
50	179.00	360.60	-	-	-	-	-	-	-	32	
		361.59	-	-	-	-	-	-	-		
51	17.50	365.76	2.38	2.28	49.84	26.60	D3000 16 LAVENDER	19	NMB25LF		72
52	7.50	373.26	1.45	1.52	49.80	27.03	D3000 13 GOLD/LIME	20	NMB25LF		78
53	7.33	380.59	1.46	1.52	49.77	27.02	D3000 13 GOLD/LIME	21	NMB25LF		84
54	7.34	387.93	1.49	1.52	49.73	27.00	D3000 13 GOLD/LIME	22	NMB25LF		84
55	7.33	395.26	1.54	1.52	49.69	26.98	D3000 13 GOLD/LIME	23	NMB25LF		90
56	7.50	402.76	1.53	1.52	49.65	26.98	D3000 13 GOLD/LIME	24	NMB25LF		90
57	7.00	409.76	1.56	1.52	49.61	26.97	D3000 13 GOLD/LIME	25	NMB25LF		96
58	7.50	417.26	1.62	1.52	49.58	26.94	D3000 13 GOLD/LIME	26	NMB25LF		96
59	7.33	424.59	1.63	1.73	49.54	26.94	D3000 14 LIME	27	NMB25LF		102
60	7.34	431.93	1.66	1.73	49.50	26.92	D3000 14 LIME	28	NMB25LF		102
61	7.33	439.26	1.71	1.73	49.46	26.90	D3000 14 LIME	29	NMB25LF		102
62	7.50	446.76	1.70	1.73	49.43	26.90	D3000 14 LIME	30	NMB25LF		102
63	7.00	453.76	1.72	1.73	49.39	26.89	D3000 14 LIME	31	NMB25LF		102
64	7.50	461.26	1.79	1.73	49.36	26.86	D3000 14 LIME	32	NMB25LF		102
65	7.33	468.59	1.80	1.73	49.32	26.86	D3000 14 LIME	33	NMB25LF		102
66	7.34	475.93	1.83	1.73	49.28	26.84	D3000 14 LIME	34	NMB25LF		102
67	7.33	483.26	1.88	2.02	49.25	26.82	D3000 15 LIME/LAV	35	NMB25LF		96
68	7.50	490.76	1.86	1.73	49.21	26.82	D3000 14 LIME	36	NMB25LF		96
69	7.00	497.76	1.89	2.02	49.18	26.81	D3000 15 LIME/LAV	37	NMB25LF		90
70	7.50	505.26	1.96	2.02	49.14	26.78	D3000 15 LIME/LAV	38	NMB25LF		90
71	7.33	512.59	1.97	2.02	49.11	26.77	D3000 15 LIME/LAV	39	NMB25LF		84
72	7.34	519.93	2.00	2.02	49.08	26.76	D3000 15 LIME/LAV	40	NMB25LF		84
73	7.33	527.26	2.05	2.02	49.04	26.74	D3000 15 LIME/LAV	41	NMB25LF		78
74	7.50	534.76	2.45	2.58	49.01	26.55	D3000 17 LAV/GRAY	42	NMB25LF		72
TOWER 3											
75	179.00	539.60	-	-	-	-	-	-	-	33	
		540.59	-	-	-	-	-	-	-		
76	10.00	544.76	2.49	2.58	48.96	26.53	D3000 17 LAV/GRAY	43	NMB25LF		72
77	7.50	552.26	2.14	2.01	48.93	26.69	D3000 15 LIME/LAV	44	NMB25LF		78
78	7.33	559.59	2.15	2.28	48.90	26.69	D3000 16 LAVENDER	45	NMB25LF		84
79	7.34	566.93	2.18	2.28	48.86	26.67	D3000 16 LAVENDER	46	NMB25LF		84
80	7.33	574.26	2.23	2.28	48.83	26.65	D3000 16 LAVENDER	47	NMB25LF		90
81	7.50	581.76	2.21	2.28	48.80	26.66	D3000 16 LAVENDER	48	NMB25LF		90
82	7.00	588.76	2.23	2.28	48.77	26.65	D3000 16 LAVENDER	49	NMB25LF		96
83	7.50	596.26	2.31	2.28	48.74	26.61	D3000 16 LAVENDER	50	NMB25LF		96
84	7.33	603.59	2.32	2.28	48.71	26.61	D3000 16 LAVENDER	51	NMB25LF		102
85	7.34	610.93	2.34	2.28	48.68	26.60	D3000 16 LAVENDER	52	NMB25LF		102
86	7.33	618.26	2.40	2.28	48.65	26.57	D3000 16 LAVENDER	53	NMB25LF		102
87	7.50	625.76	2.37	2.28	48.62	26.58	D3000 16 LAVENDER	54	NMB25LF		102

OUTLET NO.	LAST OUTLET	DISTANCE TO PIVOT	GPM NEED	GPM DEL.	PIPE PSI	NOZZLE PSI	SPRINKLER LABEL AND NOZZLE SIZE		SPRK NO.	REQ SIZE	PLUG NO.
130	7.33	932.26	3.62	3.54	46.88	25.99	D3000 20 TURQUOISE		95	NNB25LF	90
131	7.50	939.76	3.57	3.54	46.84	26.01	D3000 20 TURQUOISE		96	NNB25LF	90
132	7.00	946.76	3.60	3.54	46.81	26.00	D3000 20 TURQUOISE		97	NNB25LF	96
133	7.50	954.26	3.71	3.83	46.78	25.95	D3000 21 TURQ/YEL		98	NNB25LF	96
134	7.33	961.59	3.70	3.83	46.75	25.96	D3000 21 TURQ/YEL		99	NNB25LF	102
135	7.34	968.93	3.72	3.83	46.71	25.95	D3000 21 TURQ/YEL		100	NNB25LF	102
136	7.33	976.26	3.79	3.83	46.68	25.92	D3000 21 TURQ/YEL		101	NNB25LF	102
137	7.50	983.76	3.73	3.83	46.65	25.94	D3000 21 TURQ/YEL		102	NNB25LF	102
138	7.00	990.76	3.76	3.83	46.63	25.93	D3000 21 TURQ/YEL		103	NNB25LF	102
139	7.50	998.26	3.87	3.83	46.60	25.88	D3000 21 TURQ/YEL		104	NNB25LF	102
140	7.33	1005.59	3.86	3.83	46.57	25.88	D3000 21 TURQ/YEL		105	NNB25LF	102
141	7.34	1012.93	3.89	3.82	46.54	25.87	D3000 21 TURQ/YEL		106	NNB25LF	102
142	7.33	1020.26	3.96	3.82	46.52	25.84	D3000 21 TURQ/YEL		107	NNB25LF	96
143	7.50	1027.76	3.90	3.82	46.49	25.86	D3000 21 TURQ/YEL		108	NNB25LF	96
144	7.00	1034.76	3.93	3.82	46.47	25.85	D3000 21 TURQ/YEL		109	NNB25LF	90
145	7.50	1042.26	4.05	4.24	46.44	25.81	D3000 22 YELLOW		110	NNB25LF	90
146	7.33	1049.59	4.03	4.24	46.42	25.82	D3000 22 YELLOW		111	NNB25LF	84
147	7.34	1056.93	4.05	4.24	46.40	25.81	D3000 22 YELLOW		112	NNB25LF	84
148	7.33	1064.26	4.12	4.24	46.38	25.81	D3000 22 YELLOW		113	NNB25LF	78
149	7.50	1071.76	4.90	5.06	46.36	25.73	D3000 24 RED		114	NNB25LF	72
TOWER 6											
150	179.00	1076.60									36
151	10.00	1081.76	4.93	5.06	46.33	25.73	D3000 24 RED		115	NNB25LF	72
152	7.50	1089.26	4.20	4.24	46.31	25.80	D3000 22 YELLOW		116	NNB25LF	78
153	7.33	1096.59	4.18	4.24	46.30	25.80	D3000 22 YELLOW		117	NNB25LF	84
154	7.34	1103.93	4.21	4.24	46.28	25.80	D3000 22 YELLOW		118	NNB25LF	84
155	7.33	1111.26	4.28	4.24	46.26	25.79	D3000 22 YELLOW		119	NNB25LF	90
156	7.50	1118.76	4.22	4.24	46.25	25.80	D3000 22 YELLOW		120	NNB25LF	90
157	7.00	1125.76	4.24	4.24	46.23	25.79	D3000 22 YELLOW		121	NNB25LF	96
158	7.50	1133.26	4.37	4.23	46.22	25.78	D3000 22 YELLOW		122	NNB25LF	96
159	7.33	1140.59	4.36	4.23	46.20	25.78	D3000 22 YELLOW		123	NNB25LF	102
160	7.34	1147.93	4.39	4.23	46.19	25.78	D3000 22 YELLOW		124	NNB25LF	102
161	7.33	1155.26	4.48	4.59	46.18	25.77	D3000 23 YEL/RED		125	NNB25LF	102
162	7.50	1162.76	4.40	4.23	46.16	25.78	D3000 22 YELLOW		126	NNB25LF	102
163	7.00	1169.76	4.44	4.59	46.15	25.77	D3000 23 YEL/RED		127	NNB25LF	102
164	7.50	1177.26	4.55	4.59	46.14	25.76	D3000 23 YEL/RED		128	NNB25LF	102
165	7.33	1184.59	4.53	4.59	46.13	25.77	D3000 23 YEL/RED		129	NNB25LF	102
166	7.34	1191.93	4.56	4.59	46.12	25.76	D3000 23 YEL/RED		130	NNB25LF	102
167	7.33	1199.26	4.63	4.59	46.11	25.76	D3000 23 YEL/RED		131	NNB25LF	96
168	7.50	1206.76	4.56	4.59	46.11	25.76	D3000 23 YEL/RED		132	NNB25LF	96
169	7.00	1213.76	4.58	4.59	46.10	25.76	D3000 23 YEL/RED		133	NNB25LF	90
170	7.50	1221.26	4.72	4.59	46.09	25.75	D3000 23 YEL/RED		134	NNB25LF	90
171	7.33	1228.59	4.71	4.59	46.08	25.75	D3000 23 YEL/RED		135	NNB25LF	84
172	7.34	1235.93	4.76	4.59	46.08	25.75	D3000 23 YEL/RED		136	NNB25LF	84
173	7.33	1243.26	4.87	5.06	46.07	25.73	D3000 24 RED		137	NNB25LF	78

DEALER

AGRI LINES IRRIGATION
115 NORTH SECOND
PARMA, IDAHO 83660

CP-3
TREASURE VALLEY
DAIRY #2

TOTAL TARGET GPM	280.00
PIVOT PRESSURE	52.00
ENDGUN TARGET GPM	79.32
NUMBER OF OUTLETS	89
PIPE I.D.	LENGTH
6.395	203.60
5.369	402.00
3.806	44.87

FRICTION FACTOR USED	138
TOTAL LENGTH	650.47
NUMBER OF TOWERS	3
NUMBER OF SPRINKLERS	58

NELSON R3000 ROTATORS WITH D4 GREEN PLATES FIRST 21 POSITIONS
NELSON D3000 SPRAYS WITH FLAT FINE GROOVE PLATES BALANCE
NELSON BLUE TOP 25 LF INTEGRAL SERIES REGULATORS
DROPS AVERAGE 7.5 FT OF .75 I.D. FLEXIBLE HOSE WITH EXTERNAL GALVANIZED WEIGHTS
ELEVATION IS 0 FT UP AND 0 FT DOWN

CAUTIONS AND WARNINGS

1. Inadequate crop clearance and/or structural interference may cause poor water distribution, resulting in decreased uniformity and possible streaking.
2. Over watering at beginning of system due to practical limitations on smallest nozzle sizes available and/or allowable for proper operation.
3. Mixing of two or more different sprinkler types usually results in pattern variances at the point where the sprinklers mix, due to differences in water pattern and distance of throw.

OUTLET NO.	LAST OUTLET	DISTANCE TO PIVOT	GPM NEED	GPM DEL.	PIPE PSI	NOZZLE PSI	SPRINKLER LABEL AND NOZZLE SIZE	SPRK NO.	REG SIZE	PLUG NO.	DROP LENGTH
44	14.67	318.93	4.27	4.24	51.18	25.84	R3000 22 YELLOW	18	NMB25LF		102
45		326.26	-	-	-	-	-	-	-	27	
46	14.83	333.76	4.45	4.59	51.14	25.83	R3000 23 YEL/RED	19	NMB25LF		96
47		340.76	-	-	-	-	-	-	-	28	
48	14.50	348.26	4.61	4.59	51.09	25.81	R3000 23 YEL/RED	20	NMB25LF		90
49		355.59	-	-	-	-	-	-	-	29	
50	14.67	362.93	4.86	5.07	51.05	25.79	R3000 24 RED	21	NMB25LF		84
51		370.26	-	-	-	-	-	-	-	30	
52	14.83	377.76	-	-	-	-	-	-	-		
TOWER 2		179.00	4.24	4.24	51.00	25.84	R3000 22 YELLOW	22	NMB25LF		72
53		383.59	-	-	-	-	-	-	-	31	
54	10.00	387.76	3.07	3.20	50.98	26.30	D3000 19 GRAY/TURQ	23	NMB25LF		72
55	7.50	395.26	2.65	2.57	50.96	26.49	D3000 17 LAV/GRAY	24	NMB25LF		78
56	7.33	402.59	2.68	2.57	50.94	26.48	D3000 17 LAV/GRAY	25	NMB25LF		84
57	7.34	409.93	2.73	2.85	50.92	26.45	D3000 18 GRAY	26	NMB25LF		84
58	7.33	417.26	2.80	2.85	50.90	26.42	D3000 18 GRAY	27	NMB25LF		90
59	7.50	424.76	2.79	2.85	50.88	26.42	D3000 18 GRAY	28	NMB25LF		90
60	7.00	431.76	2.83	2.85	50.87	26.41	D3000 18 GRAY	29	NMB25LF		96
61	7.50	439.26	2.95	2.84	50.85	26.35	D3000 18 GRAY	30	NMB25LF		96
62	7.33	446.59	2.97	2.84	50.83	26.34	D3000 18 GRAY	31	NMB25LF		102
63	7.34	453.93	3.02	2.84	50.82	26.32	D3000 18 GRAY	32	NMB25LF		102
64	7.33	461.26	3.11	3.20	50.80	26.28	D3000 19 GRAY/TURQ	33	NMB25LF		102
65	7.50	468.76	3.08	3.20	50.79	26.29	D3000 19 GRAY/TURQ	34	NMB25LF		102
66	7.00	475.76	3.13	3.20	50.77	26.27	D3000 19 GRAY/TURQ	35	NMB25LF		102
67	7.50	483.26	3.25	3.19	50.76	26.21	D3000 19 GRAY/TURQ	36	NMB25LF		102
68	7.33	490.59	3.26	3.19	50.75	26.21	D3000 19 GRAY/TURQ	37	NMB25LF		102
69	7.34	497.93	3.31	3.19	50.73	26.18	D3000 19 GRAY/TURQ	38	NMB25LF		102
70	7.33	505.26	3.40	3.55	50.72	26.14	D3000 20 TURQ/OISE	39	NMB25LF		96
71	7.50	512.76	3.37	3.19	50.71	26.15	D3000 19 GRAY/TURQ	40	NMB25LF		96
72	7.00	519.76	3.43	3.55	50.70	26.13	D3000 20 TURQ/OISE	41	NMB25LF		90
73	7.50	527.26	3.55	3.54	50.69	26.07	D3000 20 TURQ/OISE	42	NMB25LF		90
74	7.33	534.59	3.56	3.54	50.68	26.07	D3000 20 TURQ/OISE	43	NMB25LF		84
75	7.34	541.93	3.61	3.54	50.67	26.04	D3000 20 TURQ/OISE	44	NMB25LF		84
76	7.33	549.26	3.70	3.83	50.66	26.00	D3000 21 TURQ/YEL	45	NMB25LF		78
77	7.50	556.76	4.22	4.24	50.65	25.84	D3000 22 YELLOW	46	NMB25LF		72
TOWER 3		179.00									
78	9.21	565.97	4.28	4.24	50.64	25.83	D3000 22 YELLOW	47	NMB25LF		72
79	7.50	573.47	3.86	3.83	50.63	25.93	D3000 21 TURQ/YEL	48	NMB25LF		72
80	7.33	580.80	3.87	3.83	50.62	25.92	D3000 21 TURQ/YEL	49	NMB25LF		78
81	7.34	588.14	3.92	3.83	50.61	25.90	D3000 21 TURQ/YEL	50	NMB25LF		78
82	7.33	595.47	4.02	3.82	50.61	25.86	D3000 21 TURQ/YEL	51	NMB25LF		78
83	7.50	602.97	4.06	4.24	50.60	25.85	D3000 22 YELLOW	52	NMB25LF		84
PIPS ID CHANGES FROM											
84	7.17	610.14	4.03	3.82	50.57	25.86	D3000 21 TURQ/YEL	53	NMB25LF		84
85	7.33	617.47	4.16	4.24	50.54	25.84	D3000 22 YELLOW	54	NMB25LF		84

LINDSAY 307

MARCH 3 1998

WISHNW-2464NW

DEALER

AGRI LINES IRRIGATION
115 NORTH SECOND
PARMA IDAHO 83660

**CP-5
TREASURE VALLEY
DAIRY #2**

TOTAL TARGET GPM	900.00
PIVOT PRESSURE	60.00
ENDGUN TARGET GPM	121.82
NUMBER OF OUTLETS	148
PIPE I.D.	LENGTH
6.395	1282.85

FRICITION FACTOR USED	135
TOTAL LENGTH	1282.85
NUMBER OF TOWERS	8
NUMBER OF SPRINKLERS	146

NELSON SPRAY I WITH CONCAVE MEDIUM GROOVE PLATES
NELSON ALL BLACK 15 PSI SERIES REGULATORS
DROPS AVERAGE 8 FT OF .75 I.D. FLEXIBLE HOSE WITH EXTERNAL POLYWEIGHTS(R)
ELEVATION IS 0 FT UP AND 0 FT DOWN

CAUTIONS AND WARNINGS

1. Over watering at beginning of system due to practical limitations on smallest nozzle sizes available and/or allowable for proper operation.

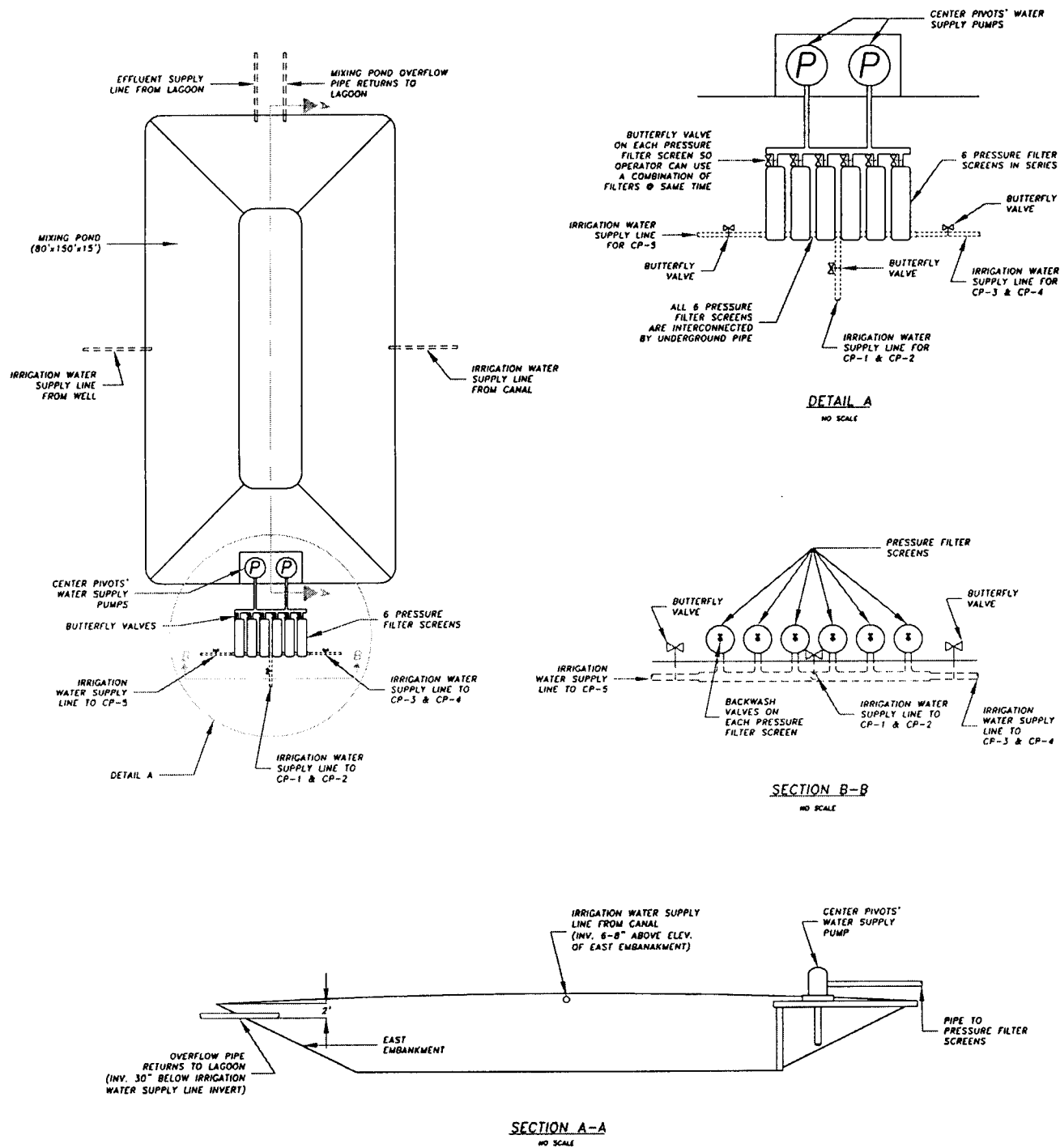
OUTLET NO.	LAST OUTLET	DISTANCE TO PIVOT	GPH NEED	GPH DEL.	PIPE PSI	NOZZLE PSI	SPRINKLER LABEL AND NOZZLE SIZE	SPRK NO.	REQ SIZE	PLUG NO.	DROP LENGTH
40	8.92	346.62	2.92	2.86	53.97	16.92	NELSON SPRAY I 5/32	38	NAB15HF		90
41	8.92	355.54	2.78	2.86	53.83	16.98	NELSON SPRAY I 5/32	39	NAB15HF		96
42	7.67	363.21	2.63	2.59	53.71	17.05	NELSON SPRAY I 19/128	40	NAB15HF		96
43	7.66	370.87	2.68	2.59	53.58	17.02	NELSON SPRAY I 19/128	41	NAB15HF		102
44	7.66	378.53	2.74	2.86	53.46	16.99	NELSON SPRAY I 5/32	42	NAB15HF		102
45	7.67	386.20	2.96	2.85	53.35	16.88	NELSON SPRAY I 5/32	43	NAB15HF		102
46	8.58	394.78	3.20	3.13	53.21	16.76	NELSON SPRAY I 21/128	44	NAB15HF		102
47	8.58	403.36	3.27	3.13	53.08	16.72	NELSON SPRAY I 21/128	45	NAB15HF		102
48	8.58	411.94	3.34	3.43	52.95	16.69	NELSON SPRAY I 11/64	46	NAB15HF		102
49	8.58	420.52	3.47	3.42	52.82	16.62	NELSON SPRAY I 11/64	47	NAB15HF		96
50	8.92	429.44	3.62	3.73	52.68	16.55	NELSON SPRAY I 23/128	48	NAB15HF		96
51	8.92	438.36	3.69	3.72	52.55	16.51	NELSON SPRAY I 23/128	49	NAB15HF		90
52	8.92	447.28	3.77	3.72	52.42	16.47	NELSON SPRAY I 23/128	50	NAB15HF		84
53	8.92	456.20	3.84	3.72	52.29	16.43	NELSON SPRAY I 23/128	51	NAB15HF		78
54	8.92	465.12	4.42	4.35	52.16	16.15	NELSON SPRAY I 25/128	52	NAB15HF		72
TOWER 3 156.43 470.70											
55	11.17	476.29	4.51	4.34	52.00	16.10	NELSON SPRAY I 25/128	53	NAB15HF		72
56	8.92	485.21	4.09	4.02	51.87	16.30	NELSON SPRAY I 3/16	54	NAB15HF		78
57	8.92	494.13	4.16	4.02	51.75	16.26	NELSON SPRAY I 3/16	55	NAB15HF		84
58	8.92	503.05	4.24	4.36	51.62	16.22	NELSON SPRAY I 25/128	56	NAB15HF		90
59	8.92	511.97	4.01	4.03	51.50	16.33	NELSON SPRAY I 3/16	57	NAB15HF		96
60	7.67	519.64	3.76	3.72	51.39	16.44	NELSON SPRAY I 23/128	58	NAB15HF		96
61	7.66	527.30	3.82	3.71	51.29	16.42	NELSON SPRAY I 23/128	59	NAB15HF		102
62	7.66	534.96	3.87	4.03	51.19	16.39	NELSON SPRAY I 3/16	60	NAB15HF		102
63	7.67	542.63	4.17	4.02	51.08	16.25	NELSON SPRAY I 3/16	61	NAB15HF		102
64	8.58	551.21	4.47	4.34	50.97	16.10	NELSON SPRAY I 25/128	62	NAB15HF		102
65	8.58	559.79	4.54	4.69	50.86	16.07	NELSON SPRAY I 13/64	63	NAB15HF		102
66	8.58	568.37	4.61	4.68	50.75	16.04	NELSON SPRAY I 13/64	64	NAB15HF		102
67	8.58	576.95	4.77	4.67	50.64	15.96	NELSON SPRAY I 13/64	65	NAB15HF		96
68	8.92	585.87	4.94	5.02	50.53	15.88	NELSON SPRAY I 27/128	66	NAB15HF		96
69	8.92	594.79	5.01	5.02	50.41	15.84	NELSON SPRAY I 27/128	67	NAB15HF		90
70	8.92	603.71	5.09	5.01	50.30	15.82	NELSON SPRAY I 27/128	68	NAB15HF		84
71	8.92	612.63	5.16	5.01	50.20	15.81	NELSON SPRAY I 27/128	69	NAB15HF		78
72	8.92	621.55	5.91	5.74	50.09	15.63	NELSON SPRAY I 29/128	70	NAB15HF		72
TOWER 4 156.43 627.13											
73	11.17	632.72	6.00	6.12	49.96	15.61	NELSON SPRAY I 15/64	71	NAB15HF		72
74	8.92	641.64	5.41	5.37	49.85	15.74	NELSON SPRAY I 7/32	72	NAB15HF		78
75	8.92	650.56	5.49	5.36	49.75	15.72	NELSON SPRAY I 7/32	73	NAB15HF		84
76	8.92	659.48	5.56	5.75	49.65	15.71	NELSON SPRAY I 29/128	74	NAB15HF		90
77	8.92	668.40	5.24	5.37	49.55	15.78	NELSON SPRAY I 7/32	75	NAB15HF		96
78	7.67	676.07	4.90	5.02	49.47	15.88	NELSON SPRAY I 27/128	76	NAB15HF		96

OUTLET NO.	LAST OUTLET	DISTANCE TO PIVOT	GPH NEED	GPH DEL.	PIPE PSI	NOZZLE PSI	SPRINKLER LABEL AND NOZZLE SIZE	SPRK NO.	REG SIZE	PLUG NO.	DROP LENGTH
118	8.58	1020.50	8.25	8.13	46.88	15.06	NELSON SPRAY I 35/128	116	NAB15HF		102
119	8.58	1029.08	8.33	8.12	46.84	15.04	NELSON SPRAY I 35/128	117	NAB15HF		102
120	8.58	1037.66	8.40	8.58	46.81	15.03	NELSON SPRAY I 9/32	118	NAB15HF		102
121	8.58	1046.24	8.64	8.56	46.78	14.97	NELSON SPRAY I 9/32	119	NAB15HF		96
122	8.92	1055.16	8.88	9.02	46.74	14.92	NELSON SPRAY I 37/128	120	NAB15HF		96
123	8.92	1064.08	8.95	9.01	46.71	14.90	NELSON SPRAY I 37/128	121	NAB15HF		90
124	8.92	1073.00	9.02	9.01	46.68	14.89	NELSON SPRAY I 37/128	122	NAB15HF		84
125	8.92	1081.92	9.10	9.00	46.65	14.87	NELSON SPRAY I 37/128	123	NAB15HF		78
126	8.92	1090.84	10.34	10.36	46.63	14.61	NELSON SPRAY I 5/16	124	NAB15HF		72
POWER 7	156.43	1096.42									
127	11.17	1102.01	10.43	10.36	46.60	14.59	NELSON SPRAY I 5/16	125	NAB15HF		72
128	8.92	1110.93	9.35	9.46	46.57	14.81	NELSON SPRAY I 19/64	126	NAB15HF		78
129	8.92	1119.85	9.42	9.46	46.55	14.80	NELSON SPRAY I 19/64	127	NAB15HF		84
130	8.92	1128.77	9.49	9.45	46.53	14.78	NELSON SPRAY I 19/64	128	NAB15HF		90
131	8.92	1137.69	8.90	9.01	46.51	14.91	NELSON SPRAY I 37/128	129	NAB15HF		96
132	7.67	1145.36	8.27	8.12	46.49	15.05	NELSON SPRAY I 35/128	130	NAB15HF		96
133	7.66	1153.02	8.33	8.12	46.48	15.04	NELSON SPRAY I 35/128	131	NAB15HF		102
134	7.66	1160.68	8.40	8.58	46.46	15.02	NELSON SPRAY I 9/32	132	NAB15HF		102
135	7.67	1168.35	8.96	9.01	46.45	14.90	NELSON SPRAY I 37/128	133	NAB15HF		102
136	8.58	1176.93	9.52	9.45	46.43	14.77	NELSON SPRAY I 19/64	134	NAB15HF		102
137	8.58	1185.51	9.60	9.44	46.42	14.76	NELSON SPRAY I 19/64	135	NAB15HF		102
138	8.58	1194.09	9.68	9.44	46.41	14.74	NELSON SPRAY I 19/64	136	NAB15HF		102
139	8.58	1202.67	9.97	10.38	46.40	14.67	NELSON SPRAY I 5/16	137	NAB15HF		96
140	8.92	1211.59	10.19	10.37	46.38	14.63	NELSON SPRAY I 5/16	138	NAB15HF		96
141	8.92	1220.51	10.24	10.37	46.37	14.62	NELSON SPRAY I 5/16	139	NAB15HF		90
142	8.92	1229.43	10.30	10.36	46.36	14.61	NELSON SPRAY I 5/16	140	NAB15HF		84
143	8.92	1238.35	10.36	10.36	46.36	14.60	NELSON SPRAY I 5/16	141	NAB15HF		78
144	8.92	1247.27	10.67	10.34	46.35	14.55	NELSON SPRAY I 5/16	142	NAB15HF		72
POWER 8	156.43	1252.85									
145	9.33	1256.60	10.00	10.38	46.34	14.67	NELSON SPRAY I 5/16	143	NAB15HF		72
146	7.50	1264.10	8.85	9.02	46.34	14.92	NELSON SPRAY I 37/128	144	NAB15HF		72
147	7.50	1271.60	8.81	9.02	46.33	14.93	NELSON SPRAY I 37/128	145	NAB15HF		72
148	7.50	1279.10	9.07	9.00	46.33	14.87	NELSON SPRAY I 37/128	146	NAB15HF		72

OVERHANG 30.00 1282.85 121.89 ENDGUN (1) NELSON PC-100 .80 TB

THERE IS NO BOOSTER PUMP
FRICTION LOSS THROUGH ENDGUN VALVE IS 2.80 PSI - ENDGUN PRESSURE IS 43.53 PSI

TOTAL GPH = 900.42
GPA = 6.56



IDAHO DEPARTMENT OF AGRICULTURE

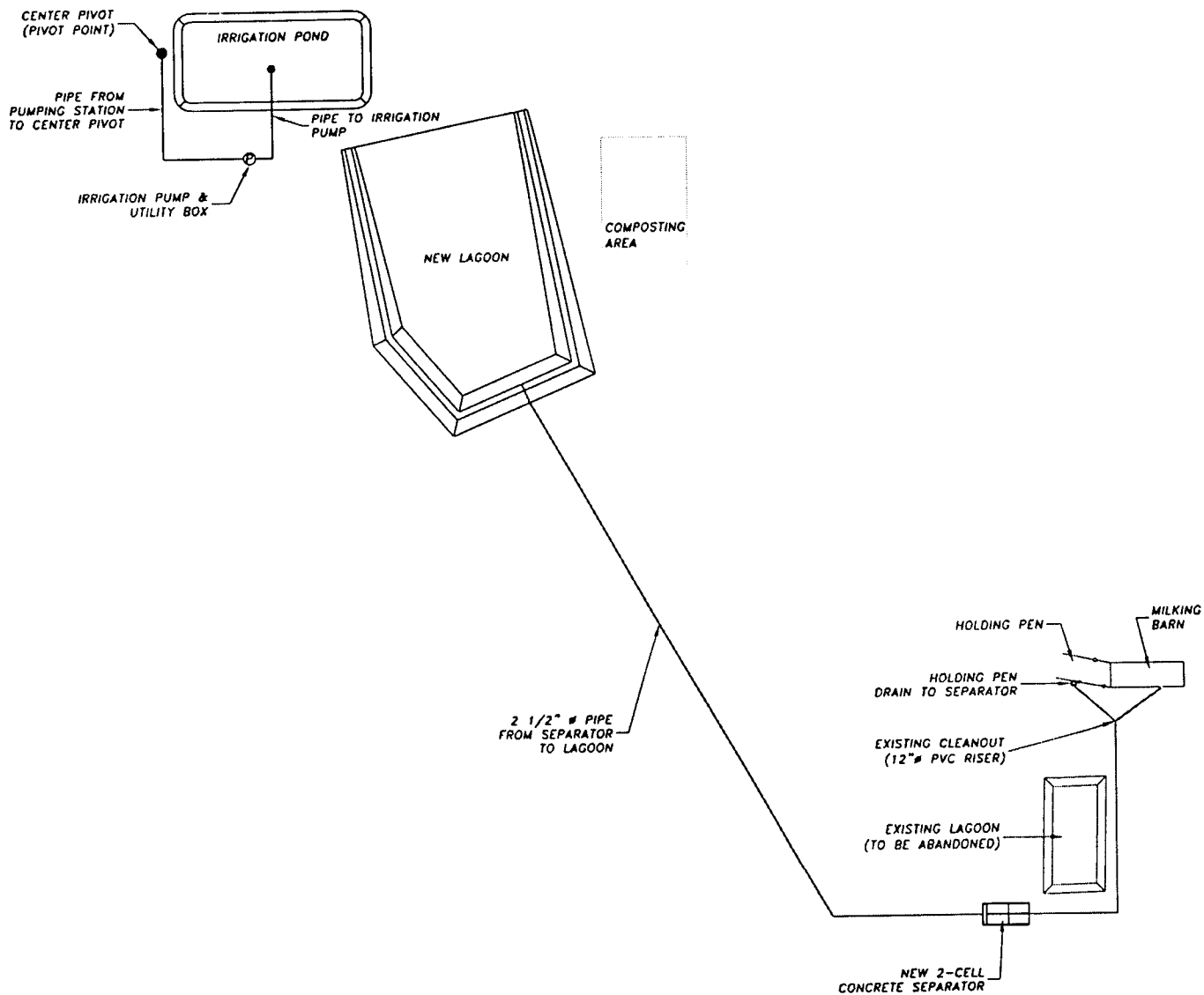
BUREAU OF DAIRYING

P.O. BOX 790 -- BOISE, ID 83701 -- (208)332-8550



LEGAL DESCRIPTION: NOT PROVIDED		GPS COORDINATES: NOT PROVIDED	
DESIGNED BY: AGRI-LINES IRRIGATION	FIGURE 2. TREASURE VALLEY DAIRY #2 CHEMIGATION SYSTEM		
DRAWN BY: TRAVIS KATOR	TREASURE VALLEY DAIRY #2	IDAHO	
DATE: 06/30/99	FILE NAME: TV#2 CHEMIGATION.DWG	SCALE: 1" = 50'	SHEET: 1 OF 1

APPENDIX C



← N



IDAHO DEPARTMENT OF AGRICULTURE

BUREAU OF DAIRYING

P.O. BOX 790 -- BOISE, ID 83701 -- (208)332-8550



LEGAL DESCRIPTION: NOT PROVIDED

GPS COORDINATES: NOT PROVIDED

DESIGNED BY: TRAVIS KATOR

FIGURE 1. MAGIC VALLEY DAIRY WASTE SYSTEM

DRAWN BY: TRAVIS KATOR

MAGIC VALLEY DAIRY

IDAHO

DATE: 06/30/99

FILE NAME: MV WS.DWG

SCALE: NO SCALE

SHEET: 1 OF 1

THE DEVELOPMENT OF A CHEMIGATION SYSTEM FOR THE APPLICATION OF DAIRY WASTEWATER

by

Travis C. Kator
Chemigation Engineer
Idaho Department of Agriculture
Boise, Idaho, USA

Written for Presentation at the
Engineering a Sustainable Agricultural and Biological Environment
The 1999 Pacific Northwest Region Meeting
Sponsored by ASAE and CSAE

Sherwood Hills Resort, Logan, Utah
September 23-25, 1999

Summary:

The Idaho Law governing chemigation of dairy waste will be discussed to demonstrate what may be required of the dairy facilities in Idaho. Two chemigation systems that are currently in place were evaluated to determine if they met the minimum requirements of the Idaho Pesticide and Chemigation Law for applying dairy wastewater and the method of application for these systems will be discussed. A pilot project is being developed with the cooperation of an Idaho dairyman and commercial dealers to develop a system that will meet the chemigation requirements and apply dairy wastewater in an efficient manner through a center pivot system.

Keywords:

Chemigation, center pivot, effluent, lagoon, land application

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